Remarks

The specification has been amended at pages 1, 2, 6, 8, 9, and 11-13, and Claims 4, 7-9, 11, 13-15, and 17 have been amended with the details set forth in Attachment I (Version with Markings to Show Changes Made). Claims 5 and 6 have been cancelled, and Claims 18-22 have been added.

Drawing Objections

With the cancellation of Claims 5 and 6 and the amendment to lines 6 and 7 of Claim 13, the objection relative to illustrating a "sealant" in Figure 3 has been overcome. As to Figure 1, the sealants 14 and 15 clearly retain the annular tubes 12 and 13 in the ends of outer tube 10. Thus, this objection should be withdrawn.

Objections to the Specification and Claims

Each of the objections to the specification and claims is believed overcome by the amendments to the specification and claims.

The 35 USC 112 Rejections

Claims 4-7 and 11-17 are rejected under 35 USC 112, first paragraph, as claiming subject matter not supported in the specification. In view of the amendments to Claims 4, 11 and 17, and the cancellation of Claims 5 and 6, it is believed that each objection raised has been overcome. Thus, this rejection should be withdrawn.

Claims 4-7 and 11-17 are rejected under 35 USC 112, second paragraph, as being indefinite. Claims 4, 11, 13, and 17 have been amended to overcome these objections. As to the objection to the term "closely adjacent" in Claim 7, such term is

widely utilized through the Office and is well recognized in patent case law, as meaning that there is no other component located intermediate the "closely adjacent" components.

In view of the amendments to these claims and the foregoing comments relative to Claim 7, it is submitted that this rejection should be withdrawn.

The 35 USC 102 Rejection

Claims 1-15 and 17 are rejected under 35 USC 102(b) as clearly anticipated by Koo et al. Claim 1, for example, sets forth "a solid member mounted in another of said pair of annular members". Koo et al is totally silent as to this feature. Claim 11 defines "a solid anode" which is clearly not taught in Koo et al. Thus, this ground of rejection is improper and should be withdrawn.

The 35 USC 103 Rejection

Claim 16 is rejected under 35 USC 103(a) as unpatentable over Koo et al. Claim 13 depends from Claim 11 and as pointed out above, this reference fails to teach the "solid anode" recited in parent Claim 11 and illustrated at 13' in Applicants' Figure 3. Thus, this rejection should be withdrawn.

Conclusion

In view of the amendments to the specification and claims and the foregoing comments, it is submitted that each objection and rejection has been overcome. Thus, this application is believed to be in condition for allowance based on Claims 1-4, and 5-17, along with new Claims 18-22 which depend from Claim 1.

Respectfully submitted,

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Enclosure:
Attachment I

Attachment I
S.N. 09/919,171
Version with Markings to Show Changes Made

In the Specification:

Page 1, paragraph (0002), amend to read as follows:

-- **[0002]** this application is a Continuation-In-Part of U.S. Application No. 09/464,668 filed December 15, 1999, now Patent No. 6,457,347, issued October 1, 2002, and entitled "Glow Discharge Detector." --

Page 1, paragraph (0003), amend to read as follows:

-- **[0003]** The present invention relates to the measurement of trace elements in a gas, particularly to the measurement of trace elements in He carrier gas of a hand-held gas chromatograph, and more particularly to a more stable glow discharge detector using a floating pseudo-electrode for measuring trace elements of the He carrier gas, the more stable glow discharge being controlled through a biased resistor, and thus constitutes an improvement over the glow discharge detector of above reference Application S.N. 09/464,668, now Patent No. 6,457,347.

Page 2, paragraph (0005), amend to read as follows:

-- **[0005]** In normal ion cells, ions are generated by either radioactive isotopes, such as nickel 63, or pulsed arc sources. The percentage of ions of the trace elements generated is dependent upon their operational modes. In an electron capture mode of operation, almost all the trace element molecules are ionized by capturing electrons. However, the mode of operation is limited to the cases where trace element molecules have electron negativity. In an ionization mode of operation, only a small portion of trace element molecules are ionized. The total amount of trace element ions is certainly

dependent upon the available sample volume. In a portable GC, the available sample volume is generally quite small, on [in] the order of micro-liters. For low concentration trace elements, the signal generated through direct electron measurement is quite small and may well be below the sensitivity of existing electron instruments. Except for more costly optical detection methods, all the prior ion cells are not applicable to small sample size in the portable GC for general applications. --

Pages 2 and 3, paragraph (0006), amend to read as follows:

-- **[0006]** Recent progress in micro-machining technology has enabled the development of miniaturized gas chromatography (GC) systems with micromachined fluidics and detectors, as exemplified by U.S. Patent No. 5,583,281 issued December 10, 1996 to C.M Yu. However, the sensitivity of these early micro GC systems was well below that of conventional systems due to limitations [limitation] of the micro thermal conductivity detectors (TCD) used in most of the micro GS systems. Thus, efforts were directed to the development of a highly sensitive micro GC detector, which could replace the TCD in most portable GC systems and which has a potential to outperform some conventional GC detectors, such as the commonly used flame ionization detector (FID), nitrogen-phosphorous detector (NPD), and electron capture detector (ECD). These prior conventionally used high performance GC detectors are also sophisticated, heavy, large and require either make-up and detector gases and/or radioactive materials to operate, and they are not suitable for field applications where portability is a top priority. --

Page 3, paragraph (0007), amend to read as follows:

-- **[0007]** A TCD, on the other hand, employs thermal conductivity differences in various gas species to sense the change in gas composition. Although a TCD lacks sensitivity when compared with a FID, NPD and ECD, it is a much simpler detector and

is much easier to be adapted for field use. Such are exemplified in U.S. Patent No. 5,591,896 issued January 7, 1997, to G. Lin, and in P. Dai et al, A Novel High Sensitivity Micro GC Detector, Transducers 99, June 7-10, 1999, pp. 696-699, Sandai, Japan. These sensors have two electrodes mounted along a single axis on a base substrate, and the two electrodes are separated by a narrow gap. One of the electrodes is tapered into a fine apex to create a strong concentration of electric field around the apex. When electric potential imposed upon the electrodes is sufficiently high, the gas molecules around the apex will be ionized. The ions and electrons generated by the ionization create an electric current flowing between the two electrodes across the gap. The electric current changes when gas composition changes because different gas molecules have different molecular structure and consequently different ionization characteristics, and this change is used as the micro detector's sensing signal. Polarity of the micro sensor can be set with the tapered electrode as either a cathode or an anode. These detectors measure the ionization properties of the sample gas in the glow discharge. --

Page 4, paragraph (0010), amend to read as follows:

-- **[0010]** The present invention provides a solution to the above-mentioned problem by providing a highly sensitive electronic ion cell which utilizes direct current (DC) glow discharge for the measurement of trace elements, in a carrier gas, such as He. The more stable glow discharge detector of this invention, like that of Application S.N. 09/464,668, now Patent No. 6,457,347, involves a constant wave (CW) direct current glow discharge controlled through a biased resistor. The glow discharge detector utilizes an extra floating pseudo-electrode to form a capacitor at the cathode dark space to detect the trace elements. The voltage drop between the cathode and the pseudo-electrode varies due to trace amounts of chemical components. --

Page 5, paragraph (0016), (0017), and (0018), amend to read as follows:

-- **[0016]** Other objects and advantages of the present invention will become apparent from the following description and accompanying drawings. The present invention involves a more stable or improved glow discharge detector and like that of Application S.N. 09/464,668, now Patent No. 6,457, 347, is particularly applicable for the measurement of trace elements in He carrier gas of a portable (hand-held) gas chromatograph. The stable glow discharge detector is of a direct current (DC), constant wave (CW) type and utilizes a floating pseudo-electrode to form a probe in the plasma. The probe enables direct measurement of the large variation of cathode drop voltage due to trace amounts of chemical components in the He carrier gas, which is many orders of magnitude larger than that caused by direct ionization or electron capture. --

-- **[0017]** The accompanying drawings, which are incorporated into and form a part of the disclosure, illustrate an embodiment of the detector of Application S.N. 09/468,668, now Patent No. 6,457,347, and on embodiment of the invention and, together with the description, serve to explain the principles of the invention. --

-- **[0018]** Figure 1 is a partial cross-sectional view of an embodiment of a glow discharge detector [detect] of Application S.N. 09/464,668, now Patent No. 6,457,347. --

Pages 5 and 6, paragraph (0021), amend to read as follows:

-- **[0021]** The present invention , like that of Application S.N. 09/464,668, now Patent No. 6,457,347, involves a highly sensitive electronic ion cell for the measurement of trace elements in a carrier gas, such as He, in a gas chromatograph (GC) which utilizes a direct current (DC), constant wave (CW) glow discharge controlled through a biased resistor. In the resistor controlled CW glow discharge, the change of electron density caused by chemical components in the He carrier gas is many orders of magnitude larger than that caused by direct ionization or electron capture. To directly

measure the electron density in the plasma of a glow discharge an extra floating pseudo-electrode has been added to form a probe in the plasma. By using this probe, chemical components can be directly measured. --

Pages 8 and 9, paragraph (0027), amend to read as follows:

-- **[0027]** As pointed out above, in a separation column of a GC, chemical trace elements are carried by a carrier gas and each separated into small gas plugs through interaction with the coating inside the column. As each plug of the trace chemical elements enters a glow discharge detector, because the molecules of these trace elements are different from those of the carrier gas in their electron affinity, molecules cross section and ionization potential, in first analysis, they certainly will cause the charge density in the bulk plasma of the glow discharge to vary. However, the charge density of a glow discharge is determined by external limitation. Any modification of the charge density in the bulk plasma by the trace elements must be instantaneously compensated by the internal field in the glow discharge detector (GDD). Variation of cathode drop voltage due to electrical current is logarithmically [logrimatic] proportional to current. --

Page 11, paragraph (0034), amend to read as follows:

-- **[0034]** Referring now to the drawings, Figure 1 illustrates in partial cross-section, the glow discharge detector made in accordance with above-referenced Application S.N. 09/464,668, now Patent No. 6,457,347. As shown, the detector, generally indicated at 10, comprises a glass tube 11 in which a pair of stainless steel or tungsten tubes 12 and 13 are coaxially mounted by a sealout, such as epoxy, indicated at 14 and 15. A tungsten member or pin 16 having a tapering end is coaxially mounted in stainless steel or tungsten tube 12 by the tube 12 being pinched as indicated at area 17, but such as to provide minimal blockage of gas flow through the detector. Glass tube

11 is mounted to a separation column of a GC whereby gas in the column passes therethrough as indicated by the gas in arrow and gas out arrow. --

Page 11 and 12, paragraph (0036), amend to read as follows:

-- **[0036]** Case 1: In a helium gas with low concentration of sample gases, because of the low possibility of ionization, these sample molecules will inter-mix with the helium gas molecules and ions in the cathode dark space and causes a decrease of the value of the large electrolytic capacitance. To maintain the same value for the surface charge on the emission point, the value of the voltage drop across the cathode dark space will have to increase. By measuring this voltage drop as the sample gases pass [passing] by, one can monitor the variation of this voltage drop due to the low concentration of the sample gases. In this case, there is a negative signal. --

Page 12, paragraph (0037), amend to read as follows:

-- **[0037]** Case 2: In a helium gas with high concentration of sample gases or sample gasses by their own, a part of the sample gases in this case will be ionized. The ionized sample molecules can increase the value of the large electrolytic capacitance in the cathode dark space. Therefore, it can lower the voltage drop across the cathode dark space. Then, in this case, there is a positive signal. --

Pages 12 and 13, paragraph (0039), amend to read as follows:

-- **[0039]** Figure 3 illustrates an embodiment of the improved or more stable glow discharge detector of the present invention. The Figure 3 embodiment differs from the Figure 1 embodiment by replacing the hollow tube anode 13 of Figure 1 with a solid rod anode made of refractory metals with low work functions such as, tungsten, molybdenum, uranium, platinum and etc., or normal metals like copper or gold which would not be poisoned by oxygen to achieve a more stable system for easier alignment.

Components of Figure 3 corresponding to those of Figure 1 are given similar reference numerals. As seen in Figure 3, the solid rod anode 13' [13¹] is supported within [with] a tube 22 that may be made of stainless steel, copper or preferably other refractory metals with low work functions such as, tungsten, molybdenum [Molybdenum], uranium [Uranium] and etc., or normal metals like copper or gold which would not be poisoned by oxygen, via a pair of pinched [pinches] areas 23 and 24 of tube 22, similar to pinched area 17 of Figure 1, or by separate support members, so as to provide minimal blockage of gas flow through the detector. The electrical circuit of Figure 2 can be used for Figure 3 also. --

In the Claims:

Claim 4, amend to read as follows:

4. (Amended) The detector of Claim 3, wherein each of said member having a tapering end and said solid member [members] having a tapering end and said solid member is composed of tungsten.

Claims 5 and 6, cancel.

Claims 7, 8, 9, 11, 13, 14, 15 and 17, amend to read as follows:

7. (Amended) The detector of Claim 1 [6], wherein said tapering end of said member is tapered to a point, and wherein said point is located closely adjacent to said solid member.

8. (Amended) The detector of Claim 1, additionally including an electrical circuit including a power supply, a capacitor, and a plurality [pair] of resistors.

9. (Amended) The detector of Claim 8, wherein said capacitor is electrically connected intermediate a [said] pair of resistors.

11. (Amended) In a hand-held gas chromatograph, the improvement comprising:

a direct current, constant wave glow discharge detector,

said detector including a solid anode, and

[including] said detector including a member having a painted end defining a Langmuin-like probe whereby [large] variations of electron density due to trace amounts of impurities in a [the] carrier gas of the gas chromatograph can be directly measured.

13. (Amended) The improvement of Claim 11, wherein said glow discharge detector includes:

an outer annular tube composed of glass,

a pair of annular tubes mounted in spaced relation in said outer annular tube and composed of stainless steel,

said pair of annular tubes being mounted in said outer annular tube, [by a sealant consisting of an epoxy],

said Langmiur-like probe [comprising a pointed member] being mounted in one of said spaced pair of annular tubes, with the [a] pointed end thereof [be] being located closely adjacent another of said pair of annular tubes, and said [pointed] member with the pointed end being composed of tungsten, and

said solid anode being mounted in said another of said pair of annular tubes [tubed].

14. (Amended) The improvement of Claim 14, wherein said [pointed] member with the pointed end member is mounted in said one of said pair of

annular tubes by at least one pinched area in said one of said pair of annular tubes.

15. (Amended) The improvement of Claim 14, wherein said [pointed] member with the pointed end said solid anode, and said pair of annular tubes are each mounted coaxially in said outer annular tube.

17. (Amended) The improvement of Claim 14, wherein, said [pointed] member with the pointed end and said solid anode are composed of [, preferably,] refractory metals with low work functions selected from the group consisting of [such as] tungsten, molybdenum, and urananium [Molybdenum, Urananium etc.] or [normal] metals composed of [like] copper or gold which would not be poisoned ["poisoned"] by oxygen.

Please add the following Claims:

18. The glow discharge detector of Claim 1, wherein said detector is controlled through a braised resistor.

19. The glow discharge detector of Claim 1, wherein said member having a tapered end and said solid member are each mounted coaxially in said first annular member.

20. The glow discharge detector of Claim 1, wherein said member having a tapered end and said solid member are mounted coaxially in said pair of annular members.

21. The glow discharge detector of Claim 1, wherein said member having a tapered end and said solid member are mounted in said pair of annular members so as to partially extend therefrom.

22. The glow discharge detector of Claim 1, wherein said pair of annular members are only partially located within said first annular member.